WE CLAIM:

1. A method for non-intrusively measuring carbon dioxide (CO_2) in a high temperature gas flow containing water vapor (H_2O), said method comprising:

providing a laser sensor;

operating said laser sensor at a selective wavelength substantially near 2 μm,

selecting the R(50) spectroscopic transition of the $\nu_1+2\nu_2+\nu_3$ CO_2 absorption band in near-infrared;

utilizing said laser sensor to spectrally interrogate said R(50) spectroscopic transition for sensitive measurements of CO_2, wherein said R(50) spectroscopic transition is substantially isolated from interfering absorption by high temperature species including said water vapor (H_2O) present in said high temperature gas flow.

2. The method of claim 1, wherein said high temperature is characterized to be more than 400 K.

3. The method of claim 1, wherein said interfering high temperature species further comprising CO, NH_3, N_2O, and NO.

4. The method of claim 1, wherein said gas flow is generated by a combustor and said measurements of CO_2 are taken *in situ* in said combustor.

5. The method of claim 1, wherein said measurements of CO_2 are taken in a process chamber or in a sampling line.

6. The method of claim 1, wherein said laser sensor comprises a fiber-coupled distributed feedback diode laser.

7. The method of claim 1, wherein said laser sensor comprises a non-fiber-coupled laser, a Fabry-Perot (FP) diode laser, a distributed Bragg reflector (DBR) laser, a quantum cascade laser, an edge-emitting diode laser, or a vertical cavity surface-emitting laser (VCSEL).

8. The method of claim 1, wherein said interrogation utilizes a spectrally resolved technique comprising scanned- and fixed-wavelength absorption, balanced ratiometric detection, frequency-modulation (FM) spectroscopy, photothermal deflection, and photoacoustic spectroscopy.

9. A system having a plurality of multiplexed laser sensors operating at a plurality of selective wavelengths for non-intrusively and simultaneously measuring combustion parameters including carbon dioxide (CO_2) along a single optical path in a high temperature gas flow containing water vapor (H_2O), wherein the improvement comprising:

one of said laser sensors operating at a wavelength substantially near 2 μm spectrally interrogates a selective R(50) spectroscopic transition of the $\nu_1+2\nu_2+\nu_3$ CO_2 absorption band in near-infrared for accurate measurements of CO_2, wherein

said R(50) spectroscopic transition is substantially isolated from interfering absorption by high temperature species present in said high temperature gas flow.

10. The system of claim 9 further comprising:

a multimode optical fiber into which output beams from said multiplexed lasers are combined;

a collimating lens for directing said combined output beams through said high temperature gas flow; and

a diffraction grating for demultiplexing said combined output beams so that transmitted intensity from each of said plurality of laser sensors as well as said combustion parameters can be simultaneously independently monitored along said single optical path by a plurality of detectors.

11. The system of claim 10, wherein said combustion parameters further comprise H_2O and temperature.

12. The system of claim 10, wherein said plurality of detectors comprise extended wavelength response detectors.

13. The system of claim 9, wherein said high temperature is characterized to be more than 400 K.

14. The system of claim 9, wherein said interfering high temperature species comprises said water vapor.

15. The system of claim 14, wherein said interfering high temperature species further comprises CO, NH_3, N_2O, and NO.

16. The system of claim 9, wherein said gas flow is generated by a combustor and said measurements of CO_2 are taken *in situ* in said combustor.

17. The system of claim 9, wherein said measurements of CO_2 are taken in a process chamber or in a sampling line.

18. The system of claim 9, wherein said plurality of laser sensors are characterized as fiber-coupled distributed feedback diode lasers.

19. The system of claim 9, wherein said plurality of laser sensors are characterized as non-fiber-coupled lasers, Fabry-Perot (FP) diode lasers, distributed Bragg reflector (DBR) lasers, quantum cascade lasers, edge-emitting diode lasers, or vertical cavity surface-emitting lasers (VCSEL).

20. The system of claim 9, wherein said interrogation utilizes a spectrally resolved technique comprising scanned- and fixed-wavelength absorption, balanced ratiometric detection, frequency-modulation (FM) spectroscopy, photothermal deflection, and photoacoustic spectroscopy.